

HW 2.2

By

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MET 440 - Heat Transfer

Dr. Ayala

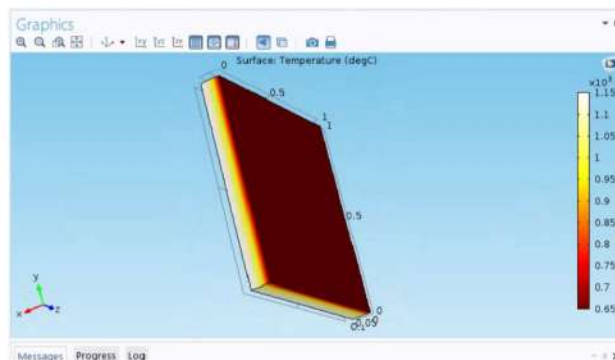
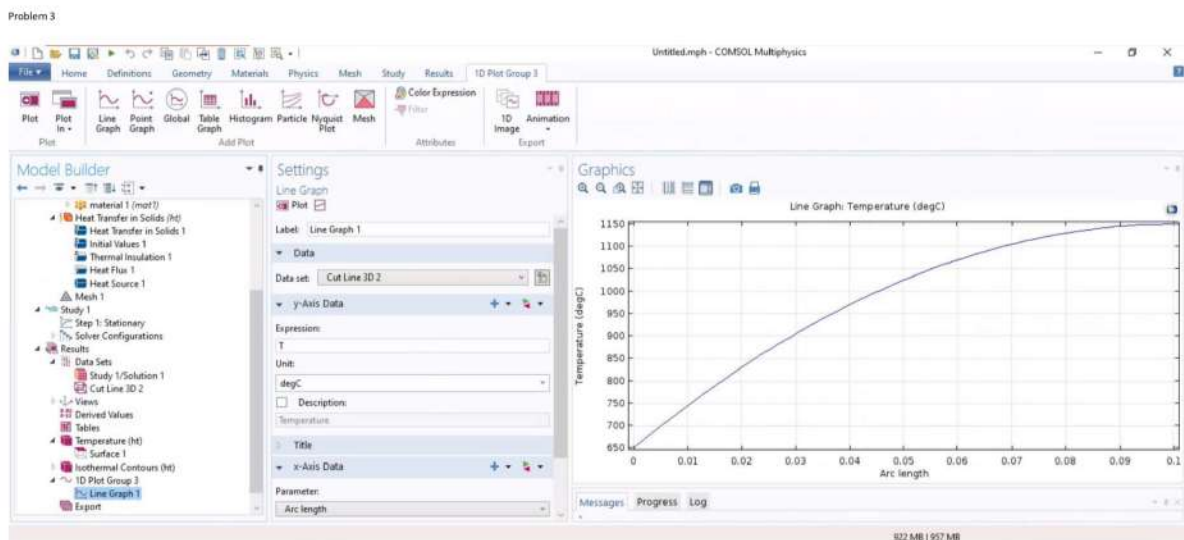
Ch5 Problems

Question 5-3

5-3 Consider a slab of thickness $L = 0.1$ m. One of the boundary surfaces, that at $x = 0$ is kept insulated, and the boundary surface at $x = L$ dissipates heat by convection with a heat transfer coefficient of $200 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$ into the ambient air at 150°C . The thermal conductivity of the wall is $10.0 \text{ W}/(\text{m} \cdot ^\circ\text{C})$, and within the wall energy is generated at a constant rate of $10^6 \text{ W}/\text{m}^3$. Determine the boundary surface temperatures.

Answers: 1150°C , 650°C

Solution

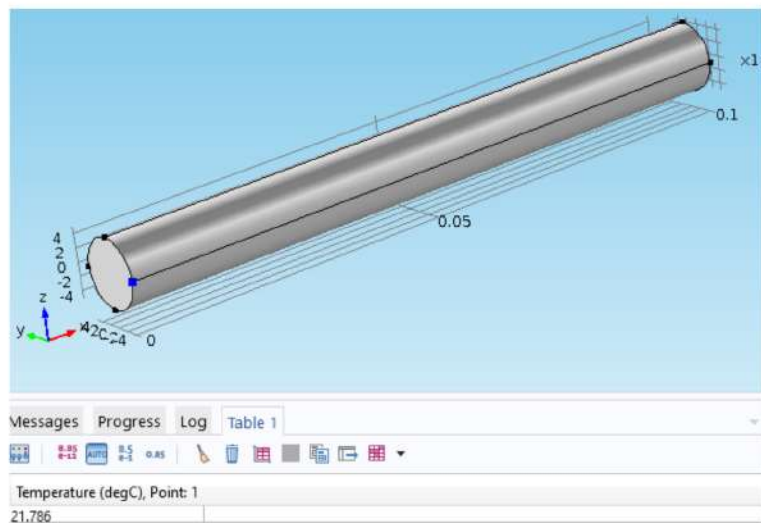


Question 5-14

5-14 Heat is generated at a constant rate of $g_0 = 10^6 \text{ W/m}^3$ in a copper rod of radius $r = 0.5 \text{ cm}$ and thermal conductivity $k = 386 \text{ W/(m}\cdot^\circ\text{C)}$. The rod is cooled by convection from its cylindrical surface into an ambient at 20°C with a heat transfer coefficient $h = 1400 \text{ W/(m}^2\cdot^\circ\text{C)}$. Determine the surface temperature of the rod.
Answer: 21.8 °C

Solution

Problem 14



Surface temperature = 21.786°C

Question 5-30

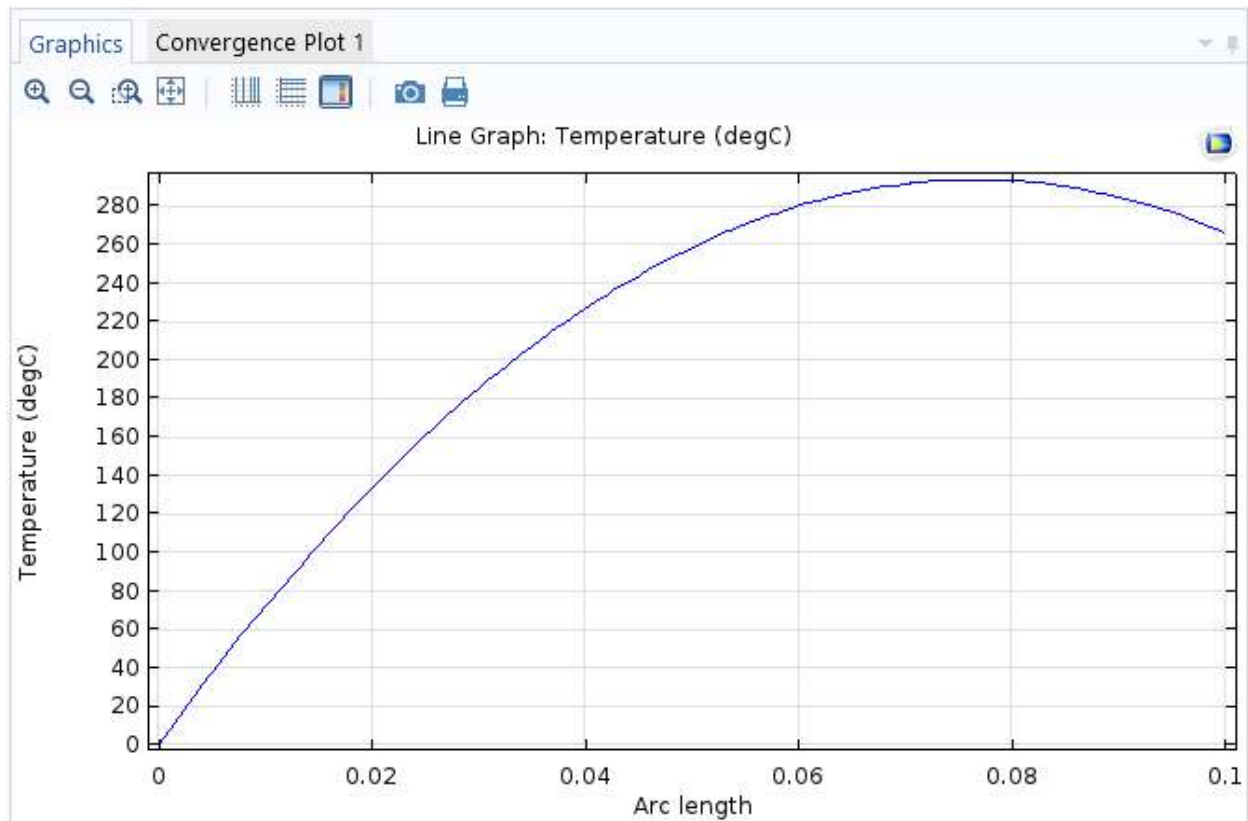
5-30 Consider the following one-dimensional, steady-state heat conduction problem:

$$\begin{aligned}\frac{d^2T(x)}{dx^2} + \frac{g}{k} &= 0 && \text{in } 0 < x < L \\ T(x) &= T_1 && \text{at } x = 0 \\ -k \frac{dT(x)}{dx} &= h_\infty [T(x) - T_\infty] && \text{at } x = L\end{aligned}$$

Write the finite-difference formulation of this heat conduction problem by dividing the region $0 \leq x \leq L$ into

- (a) Four equal parts.
- (b) Eight equal parts.
- (c) Compute the node temperatures for $k = 20 \text{ W/(m}\cdot^\circ\text{C)}$,
 $h_\infty = 400 \text{ W/(m}^2\cdot^\circ\text{C)}$, $T_\infty = 150^\circ\text{C}$, $g = 2 \times 10^6 \text{ W/m}^3$,
and $L = 10 \text{ cm}$.
- (d) Compare the numerical solutions at the nodes with the exact solution.

Solution



Activity

Our group made the decision to go with the design that reflected what we all wanted but translated in the most detail. As we compared designs, we noticed that we all had the same approaches and ideas in mind. This included a system that would feed colder temperature into the chamber containing the six packs while also expelling the warm temperature out of the chamber. We are still deciding on whether to use water or salt water to act as the medium that will flow throughout the whole system. Since COMSOL is a simulation application, we could utilize it for determining the design and construction material that can be used to cool a six pack to 40°F in five minutes. The sale price that can be gathered from our BOM is \$650.

Estimated Bill of Materials

Preliminary Cost Estimte				
Part	Quantity	Unit Price	Total Cost	Link
Cans	2	6.99	13.98	
Standard Cooler	1	79.99	79.99	https://www.target.com/p/igloo-maxcold-latitude-62qt-roller-cooler-aegean-blue/-/A-83609449#lnk=sametab
Coolant Tank	1	131	131	https://www.homedepot.com/p/5-Gal-Blue-Industrial-Plastic-Drum-PTH0933/205845768
Pump	1	172	172	https://www.lowes.com/pd/Zoeller-0-33-HPThermoplastic-Submersible-Utility-Pump/1000668957
Hardware				
Pvc Pipe (10ft)	1	6.29	6.29	https://www.homedepot.com/p/Charlotte-Pipe-3-4-in-x-10-ft-PVC-Schedule-40-Pressure-Plain-End-Pipe-PVC-04007-0600/100348

				472
Insulation Pipe (6ft)	2	3.72	7.44	https://www.homedepot.com/p/Everbilt-3-4-in-x-6-ft-Foam-Self-Seal-Pipe-Insulation-ORS07812/204760815
Tank Insulation	1	42.88	42.88	https://www.amazon.com/WATER-HEATER-INSULATION-JACKET-PREMIUM/dp/B00Z7NNXNQ?source=ps-sl-s hoppingads-lpcontent&ref_=fpifs&psc=1&smid=A917DJU8KFW86
misc Fittings				
bulk head fitting				
ball valves				
elbows				
Tees				
Wire rack				
exc	x	40	40	
Total			493.58	
Sale Price			650	